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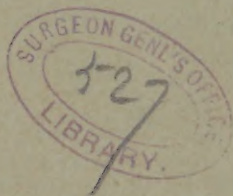
The Relation of the Function
of Accommodation to that
of Convergence.

BY

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THE RELATION OF
THE FUNCTION OF ACCOMMODATION
TO THAT OF CONVERGENCE.*

BY GEORGE T. STEVENS, M.D.

THE views of no man have been more universally and more unreservedly accepted than those of Donders, the revered investigator and pioneer in modern ophthalmology, to professional admiration for whom has been added personal devotion. Nevertheless, as new facts are added to our knowledge it is certain that some of the doctrines taught by this close and candid observer may be fairly investigated anew in the same spirit of candor which he originally brought to their consideration.

Donders affirms the proposition in regard to the relation between the accommodation and the convergence of the visual lines, that "so far as the range of accommodation for both eyes extends, the state of the accommodation of the eye corresponds to a definite convergence of the visual lines."

Donders, however, did not teach that this connection was absolute and casual, as had some of his predecessors in the same field of inquiry. He recognized the fact that under certain circumstances the relation between the two functions can be "at least partially overcome."

It is well known that in case of complete paralysis of accommodation occurring suddenly in young persons, the function of convergence remains undisturbed, and every

* Read at the International Ophthalmological Congress, Edinburgh, August 10, 1894.



one is perfectly familiar with the case of the gradual loss of accommodation from presbyopia with no loss of converging ability. The converse condition—paralysis of the converging muscles with immunity of the accommodation—presents greater difficulties in examination; yet we can not deduce a conclusion from the known facts of this condition in favor of any organic relation between the two functions. Cases long since reported by von Graefe, and many cases reported by others since then, clearly show that accommodation is retained in paralysis of the interni and in ophthalmoplegia externa.

The more recent investigations of the anatomy of the nerves controlling these functions show not only that the nucleus controlling the function of accommodation is distinctly separated from that governing the convergence, but that the nerves from each root pass separately out from the brain and that they are only united within a common sheath after they have traversed a considerable space as separated cords. All these considerations suggest that these two functions, which usually act in close agreement, so act as a result of habitual, not of organic association. In such a case, training, or a necessity which interposes important obstacles to the habitual association of action, quickly enables the individual to dissociate the two functions absolutely.

The practical issue of this paper is the consideration of this subject from the standpoint of the important deductions which Donders draws in regard to strabismus. These deductions are familiar to all, but I will repeat them. They are formulated by him thus:

“1. *Strabismus convergens* almost always depends upon *hypermetropia*.

“2. *Strabismus divergens* is usually the result of *myopia*.”

The argument is based upon the necessity of extraordinary tension of the accommodation in hyperopia, and therefore of the necessity of a correspondingly excessive tension of convergence, which at length results in permanent contracture of the converging muscles.

Consideration of the facts already mentioned does not sustain this line of argument, and only a single fact remains

as an apparent confirmation and proof of this important and ingenious doctrine. This fact is the interesting and unquestioned one that with the application of convex glasses the converging strabismus, in a certain proportion of cases, disappears, at least in some measure, to return immediately upon the removal of such glasses.

Such a striking fact can not be regarded as a coincidence, and as convex glasses applied to hypermetropic persons are supposed to have no especial office except to relieve the accommodation, the deduction is easy and natural that relieving the accommodation also relieves the tendency to squint. But the assumption is not correct either in respect to the result of accommodation upon the convergence or in respect to the action of the convex lens. Three essential facts must be considered :

1. Converging strabismus is, in not a few instances, the result of the instinctive effort to force the visual lines into the same horizontal plane in case of a normal tendency of one of these lines to rise above the other. This condition of hyperphoria, or perhaps of hypertropia, in which the image of one eye tends to appear above the other, or actually rises above, is a condition for the relief of which the subject will make the most strenuous efforts. So long as it is not overcome, the patient must acquire the faculty of mental suppression of one image—a result most easily obtained when the images are widely separated by decided squint—or see all vertical objects as though they were leaning. His own equilibrium depends upon the apparent equilibrium of surrounding objects. The instinct therefore to correct an apparent inequality in the height of the images seen by the two eyes is most urgent. In many such cases the patient, in the effort to reduce the images to a horizontal plane, willingly sacrifices single vision in that plane, and converging strabismus results.

I have elsewhere discussed this subject, and can not here enter into the details further than to assert that in an important proportion of cases of convergent strabismus a tenotomy properly done upon a superior rectus and resulting in bringing the images of the two eyes to the same horizontal plane will at once and without further procedure relieve the convergent squint.

2. In many instances it is a result of an effort to bring both eyes to a plane differing from that to which they normally tend. And it is, so far as my observation extends, only in such cases as depend on an excess of tension of the vertically acting muscles of one or both eyes that convex glasses have the effect of relieving the squint.

3. Another essential fact in relation to the relief obtained in this respect from convex glasses is that such a glass acts in a double capacity, and that its rôle in relieving strabismus is not in its capacity for relieving accommodation, but in its character as a combination of prisms. If a pair of convex glasses is placed before the eyes of one of these people, a close observer can in some instances detect at once the fact that one of the eyes seeks the position above, the other the position below the center of the lens, or at least lower than the first. Many photographic portraits which I have made show this phenomenon beautifully.

In this manner the images may be more easily brought to the horizontal plane. Let it be remembered that in a glass of 3 D. the passage of the line of vision a third of a centimetre above or below the optical center is equal to the use of a prism of one degree, and that two such glasses will serve as a very material aid in maintaining horizontal images, and that hence the tension in this respect being relieved, there remains less occasion for the extreme convergence.

The fact that this may be the action of the convex glass is shown by another fact—namely, that we may remove the spherical glasses and replace them by prisms with their bases up and down, and the effect is equally striking. This has not happened in every instance in which I have made the experiment. It is an advantage of the spherical glass that the patient may adjust the eyes to a certain degree of prisms which is not so easily determined by the surgeon, and again it is quite possible that the improved sight in some of these cases tempts the eye to seek the relief to the hyperphoria through the glass, as the prism alone does not. However that may be, I have found the prism to fail only in such cases as required the aid of the glass to obtain fairly good vision. Further, a strong cylinder with its axis horizontal or nearly so, if it serves to clear the vision by correcting an astigmatism, acts as readily in relieving some

strabismus cases as does a spherical glass in cases of pure hypermetropia; and it is also true that in some of these cases concave glasses are quite effectual in relieving the squint. There also occur many instances in which both eyes deviate vertically, and in the same direction, either equally or unequally. If we place in such a case a small card before one eye in such a way as to exclude it from fixation, the excluded eye may be seen to rise or fall as the case may be in a very marked manner. Transferring now the screen to the other eye, its behavior is similar to the first. If the first rose behind the screen, the second also rises. Such cases of double vertical divergence, as the result of the excessive tension on the opposing vertically acting recti, will often cause the eyes to squint inward, and a relief to this tension, either by prisms symmetrically placed or by relaxation of the excessive tension for both eyes, will also relieve the tendency to squint inward.* In such a case a pair of strong convex glasses may act as two vertical prisms placed with their bases in the same direction.

In many hundreds of cases in which there have existed

* This visible deviation is not essential to our knowledge of the excess of tension of the vertically acting muscles; indeed, it is only found in cases of gross deviating tendencies. Nor is the patient always able to discern any motion when a card is passed before the eyes alternately.

The lesser degrees of this anomaly can in many cases be determined only through the means of indirect tests. For example, an esophoria of several degrees with an excess of abduction most commonly indicates an excess of tension of the vertically drawing muscles, with an actual dynamic condition of exophoria so far as the tensions of the laterally acting muscles are concerned.

Many cases of what appear to be simple esophoria are in fact modified to an important degree by this too great tension on the part of the upward or downward acting muscles.

Among the class of cases of considerable esophoria in which the converging ability is materially less than normal—say six or perhaps eight inches—in the majority of instances the convergence increases at once to three or four inches if the superior muscles are equally and properly relaxed.

To determine whether the upward or downward acting muscles are the factors in the excess of tension vertically becomes a matter of importance. It is not the purpose of this paper, however, to discuss the diagnosis of these cases, and they are only alluded to in their bearing upon the subject of deviations from indirect tensions.

great or small deviations of the visual lines, and in which determinations as accurate as could be made of the deviations or deviating tendencies before and after the employment of atropine, I have found no such uniform difference in the muscular conditions before the use of atropine and after the accommodation has been paralyzed as to lead to the suggestion that any change is to be expected in these two conditions beyond the incidental and entirely temporary disturbances which may be brought about by the sudden admission of much light through a dilated pupil or the indifferent adjustments, sometimes made by persons not seeing clearly. The disturbances of balance are quickly eliminated by calling the attention of the patient to the necessity of recognizing exactly what is seen. If cures of slight cases of strabismus have occurred under the use of atropine or of eserine, the relief has come, in my opinion, from the inability to see clearly, thus enabling the patient to tolerate a slight confusion of images vertically and not from the relaxation or the stimulation of the accommodation.

There occurs in some cases of moderate esophoria a slight exophoria when strong convex glasses are applied; but while such exophoria may be indicated by the phorometer, the power of abduction is not generally increased. In these cases either a hyperphoria or a double vertical anomaly exists or the glasses, by virtue of the distance between their optical centers, act as prisms with the bases out. I have found no case which did not come under one of these two classes.

There is neither time nor necessity to go into statistics in regard to the views here presented. They are based upon close and practical observations of many hundreds of these cases, and I am sure that they will stand the test of critical examination. The conclusions at which I have arrived, from my study of this subject during many years and from abundant material, may be summarily stated in the following propositions:

1. There is no essential connection between the function of convergence and that of accommodation; such connection as exists is incidental and the result of habitual association of the two functions.

2. The proportion of the cases of converging strabismus associated with hypermetropia, and of diverging strabismus associated with myopia, has been greatly exaggerated.

3. That the cases of strabismus which are relieved by positive or negative spherical glasses are cases of hyper-tropia—that is, of a deviation of one visual line above the other, or of a deviation of both eyes upward or downward—and that the relief obtained through such glasses is largely through the action of such glasses as vertical prisms.

4. My observations have led me to believe that excessive accommodation is not directly a causative influence in converging strabismus.

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